Unit 1, Lesson 06: Answers to Homework on Metallic Bonding

1. Read pages 170 to 171.
2. Describe metallic bonding.

   Metallic bonding occurs when metal atoms "pool" their valence electrons. The positive metal ions (nucleus and full inner shells of electrons) are surrounded by a delocalized sea of valence electrons.

3. The electrons in a piece of metal are described as "delocalized". Explain what this means.

   "Delocalized" means that the electrons are not fixed in one location or associated with only one atom. Instead, they are free to move from one atom to another. In contrast, the electrons in a covalent bond are localized because they are "stuck" and shared between two non-metal atoms.

4. Explain why metals are good conductors of electricity.

   Electricity is a stream of electrons. Metals are good conductors of electricity because they have low electronegativities. They do not hold their valence electrons tightly to them, which allows a stream of electrons to pass through the metal by moving from atom to atom as part of the "electron sea".

5. Explain why metals are malleable and ductile.

   Metals are made of positive metal ions surrounded by a sea of electrons. The metal ions can easily slide past one another as they "float" in the electron sea. This allows the metal to be pounded into thin sheets or stretched into wires without breaking the metallic bonds.

6. Explain why titanium (used in aircraft) is harder and stronger than calcium.

   Titanium has four valence electrons while calcium has only two. Because titanium has more valence electrons to contribute to metallic bonding, its atoms are held in place more firmly, making it harder and stronger than calcium. Also, titanium has a higher electronegativity than calcium, which means it attracts valence electrons more tightly. This essentially increases the strength of metallic bonding. Titanium is both strong and "light" (low density), which makes it perfect for aircraft.

7. Use your periodic table to find two elements with each of the following crystal structures:

a)	(simple) cubic:	oxygen and fluorine (in their solid form)
b)	body centred cubic:	lithium, sodium, potassium, barium, vanadium, chromium etc.
c)	face centred cubic:	calcium, strontium, nickel, copper, aluminum, silver, gold etc.
d)	hexagonal:	magnesium, scandium, titanium, cobalt, zinc, cadmium, zirconium etc.

8. Define alloy.

   An alloy is a homogeneous mixture (a solution) of a base metal with other added elements (usually metals, but may contain very small proportions of non-metals such as carbon).

9. Brass is an alloy of about 85% copper and 15% zinc. How would the properties of brass compare to the properties of pure copper? Explain.

   Brass will be harder, stronger and less malleable than pure copper because the added zinc atoms contribute additional electrons for stronger metallic bonding. It is less malleable because the zinc atoms will slightly disrupt the crystal structure of pure copper. It is a substitution alloy, so it will be only slightly more difficult for the atoms to slide past one another.

10. Razor blades are often coated with an alloy of chromium and platinum to increase hardness and keep the blade sharp longer. Is this a substitution or interstitial alloy? Explain.

    Chromium atoms are much smaller than platinum atoms, so they will form an interstitial alloy. The chromium atoms are small enough to fit into the spaces between the larger platinum atoms.

11. One type of steel used to make railway tracks is an alloy of iron, chromium, and vanadium. Is this a substitution or interstitial alloy? Why isn't pure iron used for railway tracks?

    Iron, chromium and vanadium atoms are all very close to the same size (they are all close together in the same period). Because they are almost the same size, they will form a substitution alloy. This alloy will be very hard and strong so it can withstand the weight of trains travelling on the rails. Pure iron railway tracks would be too soft and malleable to make good train tracks.